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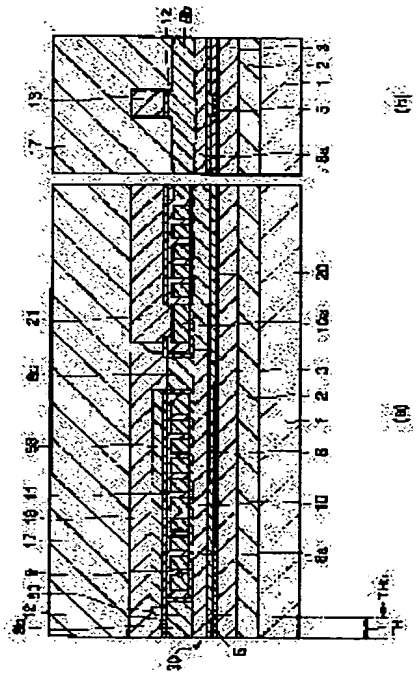
(54) THIN-FILM MAGNETIC HEAD AND ITS MANUFACTURING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a thin-film magnetic head capable of improving an electromagnetic conversion characteristics, and its manufacturing method.
SOLUTION: A recording gap layer 12 is formed on a lower magnetic layer 8. On the recording gap layer 12, the step part 58 of a nonmagnetic material having the end surface 59 of an ABS surface 30 side formed nearly perpendicularly is formed. A gap part 60 is formed in the end surface 59. On the recording gap layer 12, the gap part 60 and the step part 58, an upper magnetic pole part 13 magnetically connected to a lower magnetic pole layer 8 to constitute a closed magnetic path is formed. In addition, a thin-film coil 10 is formed through an insulating layer 11 between the upper and lower magnetic pole layers 8 and 13. In the side of the upper magnetic pole layer 13 facing the gas part 60, a slope is formed to connect the recording gap layer 12 surface with the step part 58.



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CLAIMS

[Claim(s)]
[Claim 1] The thin film magnetic head characterized by providing the following. The lower magnetic pole layer which has one magnetic pole in a ABS side side The gap layer formed on aforementioned one magnetic pole at least The level difference section of the non-magnetic material by which it was formed on the aforementioned gap layer and the end face by the side of the aforementioned ABS side was mostly formed in the perpendicular The thin film coil prepared through an insulating layer between the up magnetic pole layer which has aforementioned one magnetic pole and the magnetic pole of another side which counters, is formed at least on the aforementioned gap layer, the aforementioned opening section, and the aforementioned level difference section, is magnetically connected with the aforementioned lower magnetic pole layer, and constitutes a closed magnetic circuit, and the aforementioned vertical magnetic pole layer through the opening section formed in the aforementioned end face, and the aforementioned gap layer
[Claim 2] It is the thin film magnetic head characterized by being the thin film magnetic head according to claim 1, and specifying slow height in the aforementioned ABS side side edge section of the aforementioned opening section.
[Claim 3] It is the thin film magnetic head characterized by being the thin film magnetic head according to claim 1 or 2, and locating the aforementioned ABS side side edge section of the aforementioned opening section in the aforementioned ABS side side from the aforementioned ABS side of the magnetic pole of aforementioned another side, and the edge of an opposite side.
[Claim 4] The side which is the thin film magnetic head given in a claim 1 or any 1 term of 3, and faces the aforementioned opening section of the aforementioned up magnetic pole layer is the thin film magnetic head characterized by having the inclined plane which connects the aforementioned gap layer front face and the aforementioned level difference section.
[Claim 5] The manufacture method of the thin film magnetic head characterized by providing the following. The process which forms on a substrate the lower magnetic pole layer which has one magnetic pole in a ABS side side The process which forms a gap layer on the aforementioned lower magnetic pole layer The process which forms the level difference section of the non-magnetic material from which the end face by the side of the aforementioned ABS side becomes a perpendicular mostly on the aforementioned gap layer The process which forms the seed layer for plating processing, and the process which exposes and carries out patterning with the light exposure with which a positive resist is applied to the whole surface and the aforementioned resist remains in the aforementioned end face, Plating processing is carried out using as a mask the resist pattern with which the aforementioned resist was left behind to the aforementioned end face. The process which forms the up magnetic pole layer which has aforementioned one magnetic pole and the magnetic pole of another side which counters through the aforementioned gap layer, is magnetically connected with the aforementioned lower magnetic pole layer, and constitutes a closed magnetic circuit, The process which removes the aforementioned resist pattern and its lower layer aforementioned seed layer, and forms the opening section by the aforementioned up magnetic pole layer, the aforementioned gap layer, and the aforementioned end face, and the process which forms a thin film coil through an insulating layer between the aforementioned vertical magnetic pole layers

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[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the thin film magnetic head equipped with the induction-type magnetic-recording head, and its manufacture method.
[0002]
[Description of the Prior Art] The compound-die thin film magnetic head equipped with the magnetic-reluctance (Magnetoresistive;MR) head used for data reproduction and the induction-type magnetic head used for data logging as the magnetic head of a magnetic disk unit is used.
[0003] The MR head has the AMR element which used the anisotropy magnetic-reluctance (Anisotropic Magnetoresistive;AMR) effect, the GMR element using the huge magnetic-reluctance (Giant MagnetoResistive;GMR) effect, or the TMR element using the tunnel junction film (Tunneling Magnetoresistive;TMR) in which the magnetoresistance effect is shown further. A TMR element is used for a GMR element and a pan from the AMR element as the field recording density of a magnetic-recording medium becomes high.
[0004] There is optimization of MR height as one factor which determines the performance of these MR heads. MR height is the height of MR element from the pneumatic bearing (Air Bearing Surface:ABS) side side edge section which counters the magnetic-recording side of a magnetic-recording medium to the edge of an opposite side, and depends for this height on the amount of polishes of the ABS side in a head manufacturing process.
[0005] The induction-type magnetic head realizes the ring structure which has a narrow gap according to a semiconductor process, and a laminating is carried out through an insulator layer, and it has the vertical magnetic pole layer which has a gap (write gap) and forms a closed magnetic circuit in a ABS side side, and the thin film coil formed into the insulator layer between vertical magnetic poles. Head material is magnetized to high flux density by the record current passed in a thin film coil, a predetermined leakage magnetic field is formed on a gap, and data are recorded.
[0006] There is optimization of throat height (ThroatHeight:TH) as one factor which determines the performance of the induction-type magnetic head. Throat height is the height of the magnetic pole from a ABS side to the above-mentioned insulator layer edge, and depends also for this height on the amount of polishes of the ABS side in a head manufacturing process. In order to raise the head efficiency of a recording head, it is necessary to shorten throat height as much as possible.
[0007] In order to raise recording density, it is necessary to make track density of a magnetic-recording medium high. Therefore, it is necessary to realize the recording head which narrowed the magnetic pole width of face and gap width of face in a ABS side, and semiconductor processing technology is used.
[0008] The above-mentioned compound-die thin film magnetic head is manufactured like for example, a sputtering process, a photolithography process, and a frame plater through two or more manufacturing processes, such as an etching process and a polish process. Hereafter, it explains briefly using the thin film magnetic head which has the so-called step gap structure as an example of the manufacture method of the thin film magnetic head.
[0009] First, the aluminum2O3TiC (ARUTIKKU) substrate which is excellent in abrasion resistance with a high degree of hardness is used. This substrate itself functions as the magnetic head being completed as a main part of a slider of the magnetic head. The substrate which is excellent in abrasion resistance with a high degree of hardness is used for obtaining exact MR height and throat height, in order to secure the surfacing precision of a head. Now, for example, the chromium film which is excellent in adhesion is formed by sputtering etc. on an ARUTIKKU substrate. Subsequently, the lower shield layer which consists of a permalloy, for example is formed. Subsequently, MR element pinched by the insulator layer on the lower shield layer is formed.
[0010] Next, the up shield layer which consists of a permalloy etc. is formed. Thereby, the MR head for reproduction is completed. The up shield layer serves as the lower magnetic pole layer of the induction-type magnetic head for record. Next, the thin film coil which consists of copper etc. through an insulator layer is formed by the frame galvanizing method etc. on a lower magnetic pole layer.
[0011] Subsequently, since flattening of the thin film coil is embedded and carried out by the insulator layer, a record gap layer is formed in the upper layer. From formation of a record gap layer to formation of an up magnetic pole layer is briefly explained using drawing 9 and drawing 10 . In drawing 9 and drawing 10 , (A) is a cross section perpendicular to a ABS side, and shows the cross section cut by the A-A line of (B). (B) — a ABS side near [a part of] — the flat surface is shown First, as shown in drawing 9 (a), the end face 159 by the side of a ABS side (refer to drawing 10 (c)) forms the level difference section (step gap) 158 of the non-magnetic material which becomes a perpendicular mostly on the record gap layer 112.
[0012] Next, as shown in drawing 9 (b), after forming the seed layer 151 for plating processing, as shown in drawing 9 (c), patterning of the positive resist 152 is applied and carried out to the whole surface, and the resist frame 153 is formed in it (refer to drawing 10 (a)). Next, as shown in drawing 10 (b), the plating film which uses the frame galvanizing method for a mold, for example, consists the formed resist frame 153 of a permalloy is formed, subsequently the resist frame 153 is removed and the up magnetic pole layer 113 is formed (refer to drawing 10 (c)).
[0013] Hereafter, although illustration is omitted, patterning of the record gap layer is carried out by **********ing the up magnetic pole layer 113 by the side of a ABS side on a mask. An up magnetic pole layer is formed so that it may connect with a lower magnetic pole layer magnetically on both sides of a coil by the opposite side of a record gap layer and a closed magnetic circuit may be constituted. A protective coat is formed in the up magnetic pole layer upper layer, and a membrane formation process is completed.

[0014] Next, an ARUTIKKU substrate is cut to the cylindrical substrate containing dozens of heads. The ABS forming face of these cylindrical substrates is ground, and throat height **** with a height of about several micrometers is performed. [0015] which cuts a cylindrical substrate and two or more thin film magnetic heads complete after forming a ABS side
[Problem(s) to be Solved by the Invention] Thus, the thin film magnetic head of step gap structure forms the level difference section 158 of the non-magnetic material by which the end face 159 by the side of a ABS side was mostly formed in the perpendicular on the record gap layer 112, as shown in drawing 10 (c). By making it step gap structure, the up magnetic pole layer 113 can be formed on the flattest possible field.
[0016] Moreover, according to step gap structure, throat height is specified as height from the ABS side to the end face 159 of the level difference section 158. Here, the position of the end face 159 of the level difference section 158 turns into a throat height zero (TH0) position. Therefore, the interval between a non-illustrated lower magnetic pole layer and the up magnetic pole layer 113 is a fixed interval equal to the thickness of the record gap layer 112 up to a throat height zero position from the ABS side, and becomes large rapidly by the opposite side of a throat height zero position (namely, position of an end face 159) to a ABS side.
[0017] However, with the structure where the interval between a lower magnetic pole layer and an up magnetic pole layer changes rapidly near the throat height zero position in this way, the flow of the magnetic flux which goes to a record gap layer through a magnetic pole layer changes rapidly near the throat height zero position. a throat height zero position near [therefore,] — magnetic flux — being saturated — the electromagnetism of the thin film magnetic head — the problem that the transfer characteristic will deteriorate arises electromagnetism — the transfer characteristics are an over-writing property in the case of specifically carrying out overwrite of the data to the field already written in in data on the record medium, a nonlinear transition shift (Non-linear Transition Shift;NLTS), etc.
[0018] the purpose of this invention — electromagnetism — it is in offering the thin film magnetic head which can raise the transfer characteristic, and its manufacture method
[0019]
[Means for Solving the Problem] The lower magnetic pole layer to which the above-mentioned purpose has one magnetic pole in a ABS side side, and the gap layer formed on aforementioned one magnetic pole at least, The level difference section of the non-magnetic material by which it was formed on the aforementioned gap layer and the end face by the side of the aforementioned ABS side was mostly formed in the perpendicular, It has aforementioned one magnetic pole and the magnetic pole of another side which counters through the aforementioned gap layer with the opening section formed in the aforementioned end face. The up magnetic pole layer which is formed at least on the aforementioned gap layer, the aforementioned opening section, and the aforementioned level difference section, is magnetically connected with the aforementioned lower magnetic pole layer, and constitutes a closed magnetic circuit, It is attained by the thin film magnetic head characterized by having the thin film coil prepared through the insulating layer between the aforementioned vertical magnetic pole layers.
[0020] It is the thin film magnetic head of the above-mentioned this invention, and slow height is characterized by what is prescribed by the aforementioned ABS side side edge section of the aforementioned opening section. Moreover, the aforementioned ABS side side edge section of the aforementioned opening section is characterized by being located in the aforementioned ABS side side from the aforementioned ABS side of the magnetic pole of aforementioned another side, and the edge of an opposite side. Moreover, it is the thin film magnetic head of the above-mentioned this invention, and the side which faces the aforementioned opening section of the aforementioned up magnetic pole layer is characterized by having the inclined plane which connects the aforementioned gap layer front face and the aforementioned level difference section.
[0021] Moreover, the process which forms on a substrate the lower magnetic pole layer to which the above-mentioned purpose has one magnetic pole in a ABS side side, The process which forms a gap layer on the aforementioned lower magnetic pole layer, and the process which forms the level difference section of the non-magnetic material from which the end face by the side of the aforementioned ABS side becomes a perpendicular mostly on the aforementioned gap layer, The process which forms the seed layer for plating processing, and the process which exposes and carries out patterning with the light exposure with which a positive resist is applied to the whole surface and the aforementioned resist remains in the aforementioned end face, Plating processing is carried out using as a mask the resist pattern with which the aforementioned resist was left behind to the aforementioned end face. The process which forms the up magnetic pole layer which has aforementioned one magnetic pole and the magnetic pole of another side which counters through the aforementioned gap layer, is magnetically connected with the aforementioned lower magnetic pole layer, and constitutes a closed magnetic circuit, The process which removes the aforementioned resist pattern and its lower layer aforementioned seed layer, and forms the opening section by the aforementioned up magnetic pole layer, the aforementioned gap layer, and the aforementioned end face, It is attained by the manufacture method of the thin film magnetic head characterized by having the process which forms a thin film coil through an insulating layer between the aforementioned vertical magnetic pole layers.
[0022]
[Embodiments of the Invention] The thin film magnetic head by the gestalt and its manufacture method of 1 operation of this invention are explained using drawing 1 or drawing 8 . First, the thin film magnetic head by the gestalt and its manufacture method of this operation are explained using drawing 1 or drawing 6 . In addition, in drawing 1 or drawing 6 , (a) shows a cross section perpendicular to a ABS side, and (b) shows the cross section parallel to the ABS side of a magnetic pole portion.
[0023] First, the manufacture method of the thin film magnetic head concerning the gestalt of this operation deposits the insulating layer 2 which consists of an alumina (aluminum 2O3) at the thickness of about 5 micrometers for example, on the aluminum2O3 ARUTIKKU substrate 1 which consists of TiC, as shown in drawing 1 . Next, the lower shield layer 3 for the reproducing heads which consists of a magnetic material, for example, a permalloy, is formed on an insulating layer 2 at the thickness of about 3 micrometers. The lower shield layer 3 uses for example, a photoresist film as a mask, and forms it alternatively on an insulating layer 2 by the galvanizing method. Next, it grinds until it forms in the thickness of 4-5 micrometers the insulating layer (not shown) which consists of an alumina all over a substrate, for example, the lower shield layer 3 is exposed with CMP (chemical mechanical-polishing method), and flattening processing of the front face is carried out.
[0024] Next, as shown in drawing 2 , the lower shield gap film 4 as an insulator layer is formed on the lower shield layer 3 by the thickness of about 20-40nm. Next, the MR element 5 for reproduction is formed on the lower shield gap film 4 at the thickness of dozens of nm. The MR element 5 forms MR film formed by the spatter by **********ing alternatively.
[0025] Next, the electrode layer 6 of a couple which connects with the MR element 5 electrically is formed by the thickness of dozens of nm on the lower shield gap film 4. Next, an insulator layer with a thickness of about 20-40nm is formed on the lower shield gap film 4 and the MR element 5 as an up shield gap film 7, and the MR element 5 is laid underground in the shield gap film

4 and 7. As an insulating material used for the shield gap films 4 and 7, there are an alumina, alumimium nitride, diamond-like carbon (DLC), etc. Moreover, the shield gap films 4 and 7 may be formed by the spatter, and may be formed by the chemical vapor-growth (CVD) method. In forming the shield gap films 4 and 7 which consist of an alumina film by CVD, as a material, it uses a trimethylaluminum (aluminum3 (CH3)) and H2O. If CVD is used, it is thinly precise and the few shield gap films 4 and 7 of a pinhole can be formed.

[0026] Next, it consists of a magnetic material with a thickness of about 1.0-1.5 micrometers, and 1st partial 8a of the lower [an up shield layer-cum-] magnetic pole layer (henceforth a lower magnetic pole layer) 8 used for the both sides of the reproducing head and a recording head is alternatively formed on the up shield gap film 7. In addition, the lower magnetic pole layer 8 consists of the 1st partial 8a, and the 2nd partial 8b and 3rd partial 8c which are mentioned later. 1st partial 8a of the lower magnetic pole layer 8 is arranged in the position where the thin film coil mentioned later counters in part at least.

[0027] Next, the 2nd partial 8b of the lower magnetic pole layer 8 and 3rd partial 8c are formed on 1st [of the lower magnetic pole layer 8] partial 8a at the thickness of about 1.5-2.5 micrometers. 2nd partial 8b is connected to the near (it sets to drawing and is the bottom) field in which the magnetic pole portion of the lower magnetic pole layer 8 is formed in, and the thin film coil of 1st partial 8a is formed. 3rd partial 8c is a portion for connecting 1st partial 8a and the up magnetic pole layer mentioned later.

[0028] The 1st partial 8a of the lower magnetic pole layer 8, the 2nd partial 8b, and 3rd partial 8c may be formed by the galvanizing method using NiFe (nickel:80 % of the weight, Fe:20 % of the weight), NiFe (nickel:45 % of the weight, Fe:55 % of the weight) which is high saturation-magnetic-flux-density material, and may be formed by the spatter using material, such as FeN, FeZrN, etc. which are high saturation-magnetic-flux-density material. In addition, you may use CoFe, Co system amorphous material, etc. which are high saturation-magnetic-flux-density material.

[0029] Next, as shown in drawing 3 , the insulator layer 9 which consists of an alumina is formed in the whole at the thickness of about 0.3-0.6 micrometers. Next, patterning of the photoresist is carried out according to a photolithography process, and the resist frame 19 for forming a thin film coil by the frame galvanizing method is formed. Next, the thin film coil 10 which consists of copper (Cu) is formed by the frame galvanizing method using the resist frame 19 by the thickness of about 1.0-2.0 micrometers, and the 1.2-2.0-micrometer coil pitch. Next, the resist frame 19 is removed. In addition, connection 10a is used in order to connect with the conductive layer (lead) which mentions the thin film coil 10 later.

[0030] Next, as shown in drawing 4 , the insulating layer 11 which consists of an alumina is formed in the whole at the thickness of about 3-4 micrometers. Next, an insulating layer 11 is ground and flattening processing of the front face is carried out until the 2nd partial 8b of the lower magnetic pole layer 8 and 3rd partial 8c are exposed with CMP, for example. Although the thin film coil 10 is not exposed, you may make it exposed [the thin film coil 10] by drawing 4 here.

[0031] Next, the record gap layer 12 which consists of an insulating material is formed at the thickness of 0.2-0.3 micrometers on the 2nd partial 8b of the lower magnetic pole layer 8 and 3rd partial 8c which were exposed, and an insulating layer 11. Generally as an insulating material used for the record gap layer 12, there are an alumina, alumimium nitride, silicon oxide system material, silicon nitride system material, diamond-like carbon (DLC), etc. Moreover, the record gap layer 12 may be formed by the spatter, and may be formed by CVD. In forming the record gap layer 12 which consists of an alumina film by CVD, as a material, it uses a trimethylaluminum (aluminum3 (CH3)) and H2O. If CVD is used, it is thinly precise and the few record gap layer 12 of a pinhole can be formed.

[0032] Next, for closed magnetic circuit formation, on 3rd [of the lower magnetic pole layer 8] partial 8c, the record gap layer 12 is **********ed partially and a contact hole is formed. Moreover, in the portion on connection 10a of the thin film coil 10, the record gap layer 12 and an insulating layer 11 are **********ed partially, and a contact hole is formed.

[0033] Next, as shown in drawing 5 , the level difference section 58 which has the end face 59 which rises high over a perpendicular mostly by the ABS side 30 side, and consists of non-magnetic material with a thickness of about 0.5 micrometers is formed on the record gap layer 12. In this example, the level difference section 58 is formed just before 3rd partial 8c from the end face 59 which is in predetermined distance from the ABS side 30 side.

[0034] Next, the opening section 60 which adjoins an end face 59 on the record gap layer 12 is formed. Formation of the opening section 60 is later explained in full detail using a drawing.

[0035] Next, while applying on 3rd [of the lower magnetic pole layer 8] partial 8c from the ABS side 30 and forming the up magnetic pole layer 13 in the thickness of about 2.0-3.0 micrometers, a conductive layer 21 is formed in the thickness of about 2.0-3.0 micrometers so that it may connect with connection 10a of the thin film coil 10. Through the contact hole formed on 3rd [of the lower magnetic pole layer 8] partial 8c, it connects with 3rd partial 8c of the lower magnetic pole layer 8, and the up magnetic pole layer 13 is connected magnetically.

[0036] As mentioned above, the opening section 60 forms the opening in the position which is distant from the ABS side 30 by the end face 59 of the up magnetic pole layer 13, the record gap layer 12, and the level difference section 58. Throat height is specified by the edge by the side of the ABS side 30 of the opening section 60. For this reason, the edge by the side of the ABS side 30 of the opening section 60 is formed in the position by the side of the ABS side 30 rather than the edge of an opposite side in the ABS side 30 of 2nd partial 8b of the lower magnetic pole layer 8. The side which faces the opening section 60 of the up magnetic pole layer 13 has the inclined plane which connects record gap layer 12 front face and the level difference section 58. This inclined plane is formed the shape of a straight line, and in the shape of a curve, and is formed in a configuration which makes a part of cylinder side centering on a shaft [parallel to the ABS side 30 and] parallel to the record gap layer 12 preferably.

[0037] Using NiFe (nickel:80 % of the weight, Fe:20 % of the weight), NiFe (nickel:45 % of the weight, Fe:55 % of the weight) which is high saturation-magnetic-flux-density material, the up magnetic pole layer 13 may be formed by the galvanizing method, and may be formed by the spatter using material, such as FeN, FeZrN, etc. which are high saturation-magnetic-flux-density material. In addition, you may use CoFe, Co system amorphous material, etc. which are high saturation-magnetic-flux-density material. Moreover, it is good also as structure which laid the insulator layer of an inorganic system, and magnetic layers, such as a permalloy, on top of many layers for the up magnetic pole layer 13 because of an improvement of a RF property.

[0038] Next, the record gap layer 12 is alternatively **********ed by dry etching by using the up magnetic pole layer 13 as a mask. Reactive ion etching (RIE) which used the chlorine-based gas of BCl2 and Cl2 grade, the fluorine system gas of CF4 and SF6 grade, etc. is used for the dry etching at this time. Next, the trim structure where about about 0.3-0.6 micrometers **********s alternatively, and 2nd partial 8b of the lower magnetic pole layer 8 is shown in drawing 5 (b), for example by argon ion milling is formed. According to this trim structure, the increase in the efficiency-width of recording track by the breadth of the magnetic flux generated at the time of the writing of a ** truck can be prevented.

[0039] Next, as shown in drawing 6 , after forming in the thickness of 20–40 micrometers the overcoat layer 17 which consists of an alumina all over a substrate, flattening is carried out, and the non–illustrated pad for electrodes is formed on it. Polish processing of the slider which finally contains above–mentioned each class is performed, the ABS side 30 of a recording head and the reproducing head is formed, and the thin film magnetic head is completed.
[0040] Here, the composition of the thin film magnetic head by the gestalt of this operation is explained using drawing 6 . The thin film magnetic head by this operation gestalt has the lower magnetic layer 8 which has one magnetic pole in the ABS side 30 side, and the record gap layer 12 formed on one magnetic pole. Furthermore, it is formed on the record gap layer 12, and the end face 59 by the side of the ABS side 30 has the level difference section 58 of the non–magnetic material mostly formed in the perpendicular.
[0041] And the opening section 60 is formed in the end face 59. On the record gap layer 12, the opening section 60, and the level difference section 58, it has one magnetic pole and the magnetic pole of another side which counters through the record gap layer 12, and the up magnetic pole layer 13 which is magnetically connected with the lower magnetic pole layer 8, and constitutes a closed magnetic circuit is formed. Moreover, between the vertical magnetic pole layer 8 and 13, the thin film coil 10 is formed through the insulating layer 11.
[0042] In drawing 6 , Sign TH shows throat height and TH0 shows the throat height zero position. TH0 is prescribed in this operation gestalt by the 30th page side edge section of ABS of the opening section 60. The edge by the side of the ABS side 30 of the opening section 60 is arranged rather than the edge of an opposite side in the position by the side of the ABS side 30 in the ABS side 30 of 2nd partial 8b of the lower magnetic pole layer 8. Moreover, the side which faces the opening section 60 of the up magnetic pole layer 13 has the inclined plane which connects record gap layer 12 front face and the level difference section 58.
[0043] Next, the formation method of the opening section 60 and the up magnetic pole layer 13 is explained using drawing 7 and drawing 8 . In drawing 7 and drawing 8 , (A) is a cross section perpendicular to a ABS side, and shows the cross section cut by the A–A line of (B). (B) — a ABS side near [a part of] — the flat surface is shown
[0044] First, the level difference section 58 which is from the non–magnetic material with a thickness of about 0.5 micrometers which has the end face 59 which rises high over a perpendicular mostly on the ABS side (refer to drawing 8 (c) and (B)) side formed in the lower part side of the plan shown in (B) of drawing 7 (a) is formed on the record gap layer 12. Next, as shown in drawing 7 (b), the seed layer 51 for plating (electrode layer) is formed on the record gap layer 12 and the level difference section 58.
[0045] Next, as shown in drawing 7 (c), the resist layer 52 of a positive type is formed on the seed layer 51. Next, the resist layer 52 is exposed using a photo mask M. The photo mask M has the shading pattern corresponding to the configuration of the resist frame for forming the up magnetic pole layer 13 by the frame galvanizing method. At this time, light exposure is adjusted and exposed so that a resist layer may remain in the end face 59 of the level difference section 58.
[0046] After exposure of the resist layer 52, negatives are developed, and as shown in drawing 8 (a), while forming the resist frame 53 on the seed layer 51, the resist residual section 55 is formed in the position corresponding to the opening section on the seed layer 51 of the end face 59 of the level difference section 58. The resist residual section 55 is formed so that the edge by the side of a ABS side may be arranged in the throat height zero position TH0.
[0047] Next, as shown in drawing 8 (b), the up magnetic pole layer 13 is formed by the frame galvanizing method using the resist frame 53. Although the seed layer is not formed on the resist residual section 55, since the thickness of the plating film which forms the up magnetic pole layer 13 is far thicker than the height of the resist residual section 55, a plating layer is overhung and formed on the resist residual section 55. The up magnetic pole layer 13 which the plating layer was formed also on the resist residual section 55, and continued before and behind the resist residual section 55 by this is obtained.
[0048] Next, as shown in drawing 8 (c), with removal of the resist frame 53, the resist residual section 55 and the seed layer 51 which exists in these lower layers are removed, and the opening section 60 is formed. When wet etching removes the seed layer 51, the seed layer 51 can be removed without the seed layer 51 remaining in the bottom of the opening section 60. although the seed layer 51 may remain in the bottom of the opening section 60 in part when dry etching removes the seed layer 51 — this — electromagnetism — the transfer characteristic is hardly influenced
[0049] Thus, since according to the gestalt of this operation the opening section 60 is formed between the up magnetic pole layer 13 and the record gap layer 12 and the edge by the side of the ABS side 30 of this opening section 60 prescribed throat height The flow of the magnetic flux which goes to the record gap layer 12 through the up magnetic pole layer 13 can be smoothly changed near the edge by the side of the ABS side 30 of the opening section 60 (i.e., the throat height zero position TH0 near). consequently, the electromagnetism of a recording head — the transfer characteristic, for example, an over–writing property, and NLTS can be raised
[0050]
[Effect of the Invention] according to this invention the above passage, the flow of the magnetic flux near [which constitutes step gap structure] the level difference section end face is changed smoothly — making — electromagnetism — the transfer characteristic can be raised now

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[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a process cross section explaining the manufacture method of the thin film magnetic head by the gestalt of 1 operation of this invention.
[Drawing 2] It is a process cross section explaining the manufacture method of the thin film magnetic head by the gestalt of 1 operation of this invention.
[Drawing 3] It is a process cross section explaining the manufacture method of the thin film magnetic head by the gestalt of 1 operation of this invention.
[Drawing 4] It is a process cross section explaining the manufacture method of the thin film magnetic head by the gestalt of 1 operation of this invention.
[Drawing 5] It is a process cross section explaining the manufacture method of the thin film magnetic head by the gestalt of 1 operation of this invention.
[Drawing 6] It is drawing showing the composition of the process cross section explaining the manufacture method of the thin film magnetic head by the form of 1 operation of this invention, and the thin film magnetic head.
[Drawing 7] It is drawing explaining the formation method of the opening section in the manufacture method of the thin film magnetic head by the form of 1 operation of this invention.
[Drawing 8] It is drawing explaining the formation method of the opening section in the manufacture method of the thin film magnetic head by the form of 1 operation of this invention.
[Drawing 9] It is drawing explaining the manufacture method of the thin film magnetic head of the conventional step gap structure.
[Drawing 10] It is drawing explaining the manufacture method of the thin film magnetic head of the conventional step gap structure.
[Description of Notations]
1 Substrate
2 Insulating Layer
3 Lower Shield Layer
5 MR Element
8 Lower Magnetic Pole Layer
10 Thin Film Coil
11 Insulating Layer
12 Record Gap Layer
13 Up Magnetic Pole Layer
17 Overcoat Layer
51 Seed Layer
55 Resist Residual Section
58 Level Difference Section
59 End Face
60 Opening Section

[Translation done.]